Modelling of an Electric Power Grid for New Power Plant Evacuation

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Abstract—Injection of a new power system component into an existing power grid often cause change in the behaviour of the power grid to which it is injected. Therefore, forecasting possible unsafe condition(s) of the power grid using an efficient power study tool is essential; and, provision of necessary mitigation actions to ensure a reliable grid is important. This paper, therefore, presents evacuation study of a 400 MW power plant connecting to the 15 GW planned transmission network of the Transmission Company of Nigeria (TCN). The NEPLAN power system analytical software was used in the modelling and simulation of the electric power grid. In the research, load flow, short circuit, transient stability, and contingency analyses were performed on the case study. From the short circuit study, it is observed that if TCN network expansion program is fully implemented, the short circuit level will go beyond the existing switchgear ratings in major substations of the network. However, with the introduction of substation splitting at Omotoso and ongoing Ogijo substations, the short circuit level will be reduced by 15%; leading to improvement in the overall system stability.

Keywords—Load flow, short circuit study, transient stability study, and contingency analysis

1 INTRODUCTION

Power System is made up of several components such as generator, transmission lines, switchgears, power/potential transformers, SCADA systems etc. Whenever there is need to integrate a new component (such as a power plant) into an existing electrical power grid, there is also need to study the effect of such a component on the existing system to ensure a reliable power system. The study is known as power plant evacuation study. The study is essential in the power system planning and maintenance; because the expansion of interconnected transmission/distribution network, and growth in power generation/load of a given power system leads to changes in the characteristics (such as equipment loading, fault level, voltage profile etc.) of such a power system. These changes may lead to mechanical, electrical and thermal stresses, which may cause mal-functioning or breakdown of major components in the system. A good evacuation study discovers and provides a good alternative for any abnormality found in the course of making more power available in the network to service its consumers. To that effect, some research activities have focused attention in this direction.

An optimal analysis of power evacuation of Tiga hydro power plant in Kano State was carried out by Abdullahi et al., (2015); this research did not consider the fault contribution of the power plant to the existing network but performed a detailed load flow studies. Optimum power evacuation system planning of Malwa thermal power station was carried out by Soni et al., (2013); the study only considered the load flow studies for optimum evacuation of the power plant to Madhya Pradesh power system. The studies carried out by Abdullahi et al., (2015), and Soni et al., (2013) do not provide all the basic technical information required for seamless evacuation of a new power plant to an existing power grid. Therefore, the goal of this study is to ensure seamless integration of a new power plant to an existing power grid when completed, as well as, product evacuation and delivery to the load centres and bulk load consumers.

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In order to achieve the goal, this research entails modelling and simulation of electricity transmission grids for;

1) Power flow analyses to evaluate resultant voltage profiles and equipment loadings;
2) Short circuit studies to determine fault-current levels at various buses within the interconnected system for the purpose of checking switchgear rating adequacy and for effective protective relay coordination and setting;
3) Transient stability studies to determine the ability of the grid, with a new plant connected, to maintain equilibrium and re-establish itself into steady state condition, following a major disturbance on the network. Faults are destructive to power systems; therefore, there is need to study and forecast the possible effect of severe faults on power equipment and provide the necessary solution to be incorporated with the system expansion model for reliable and safe operation of the power system. One of the solutions to reduction of the risk of increase in short circuit level in a grid is an upgrade of the protective equipment so that the estimated fault current are kept within the equipment capacity. However, this involves complete rebuilding of the substation and represents a high cost ratio benefit (Gilany and Al-Hasawi, 2009). Furthermore, due to the number of equipment to be replaced, redesigned or tested, upgrading the existing substation can be a complicated process; but reconfiguration of the substation buses by splitting them at strategic points to increase the network positive, negative and zero sequence impedance seen by fault, will result in the reduction of the short circuit currents. Substation bus splitting (Wu et al., 2003) offers significant benefits to the power network in terms of fault level reduction. This solution is more economical than upgrading a circuit breaker (Gilany and Al-Hasawi, 2009). However, load division and network reliability need to be carefully analysed.
4) (N-1) contingency analysis to determine the security level of the network.

The rest of the paper is organized as follows: Section 2 of the paper presents materials and method adopted to achieve the goal of the study. The results obtained during the simulation exercises are presented and discussed in section 3; while the findings of the study and conclusion are presented in section 4.

2 Materials and Method

2.1 Materials

The proposed 330 kV transmission network of TCN was modelled using NEPLAN power system studies software. The network includes a generation capacity of 15 MW; which contains all existing power plants and the proposed Independent Power Plants (IPP) that have been given approval by the TCN to connect to the national grid. The planned TCN 330 kV network is available in JICA (2014).

2.1.1 NERC Grid Standards

To ensure continuous and reliable power flow, stakeholders in Nigeria Electricity Industry (NEI) must comply with the Nigerian Electricity Regulatory Commission standards (NERC, 2014), which are presented in Tables 1 through 3.

The data used in modelling the existing transmission lines, generators, loads, bus bars, substations, reactors and transformers are available in Somolu and Okafor (2007). For the proposed components/equipment, standard values are used based on their individual ratings. A peak load of 14.55 GW was used in this study; this estimate is based on the forecast from JICA (2014) on the on-going power system expansion project which is expected to be fully implemented by TCN.

Table 1. Equipment Loading

Item	Limit
Transmission lines	within 85% of thermal rating
Generators	Within 95% of name plate rating
Transformer	Within 85% of nameplate rating

Table 2. Voltage Control Limit

Voltage level	Minimum Voltage kV (pu)	Maximum Voltage kV (pu)
330 kV	280.5 (0.85)	346.5 (1.05)
132 kV	112.2 (0.85)	145.2 (1.10)
33 kV	31.02 (0.94)	34.98 (1.06)
11 kV	10.45 (0.95)	11.55 (1.05)

Table 3. Frequency Control limits

Operating condition	Minimum (Hz)	Maximum (Hz)
Normal condition (+/- 0.5%)	49.75	50.25
Under System Stress/Emergency (+/- 2.5%)	48.75	51.25

Source: NERC

2.2 Mathematical Modelling

2.2.1 Load Flow Parameter Formulation

In a typical power system, buses are classified into three types. At each type of bus, there are four parameters to be evaluated (two known and two unknown) as shown in Table 4.

The variables and parameters associated with bus i and a neighboring bus k as shown in Fig. 1 are represented in the usual notation as follows (Saadat, 2004):

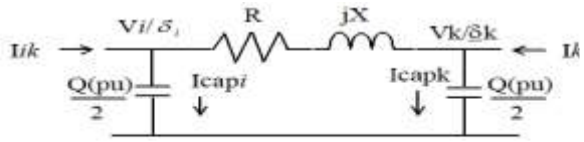

Fig.1: Equivalent pi-model of a two bus power system

$$V_i = |V_i|e^{j\delta_i} = V_i(cos\delta_i + jsin\delta_i) \quad (1)$$
$$Y_{ik} = |Y_{ik}|e^{j\theta_{ik}} = V_i(cos\theta_{ik} + jsin\theta_{ik}) \quad (2)$$

Table 4: Classification power system buses

Classification	Known	Unknown
PQ(Load Bus)	P,Q	V,δ
PV (Generator Bus)	P, V	Q, δ
Vδ (Swing Bus)	V, δ	P, Q

P= Active Power (MW), Q =Reactive Power (MVAR), V = Bus Voltage Magnitude (kV), δ = Bus Voltage Angle (Degree).

Complex power

$$S_i = P_i + jQ_i = V_iI_i^* \quad (3)$$

Using the indices G and L for generation and load,

$$P_i = P_{G_i} - P_{L_i} = Re[V_iI_i^*] \quad (4)$$
$$Q_i = Q_{G_i} - Q_{L_i} = Im[V_iI_i^*] \quad (5)$$

The bus current is given by

$$I_{bus} = Y_{bus}V_{bus} \quad (6)$$

Upon rearranging (3) and using (4) and (5) in the resulting equation, it is evident that for an n-bus system (Saadat, 2004);

$$I_i = \frac{P_i - jQ_i}{V_i^*} = Y_{ii}V_i + \sum_{\substack{k=1 \\ k\neq i}}^{n} y_{ik}V_k \quad (7)$$

Equation (7) can be re-expressed as;

$$V_i = \frac{1}{Y_{ii}}\left[\frac{P_i - jQ_i}{V_i^*} - \sum_{\substack{k=1 \\ k\neq i}}^{n} Y_{ik}V_k\right] \quad (8)$$

and

$$P_i + jQ_i = V_i\sum_{\substack{k=1 \\ k\neq i}}^{n} Y_{ik}V_k \quad (9)$$

Equation (9) can be expressed in polar form as;

$$P_i + jQ_i = \sum_{k=1}^{n}|V_iV_kY_{ik}|\, e^{j(\delta_i - \delta_k - \theta_{ik})} \quad (10)$$

so

$$P_i = \sum_{k=1}^{n}|V_iV_kY_{ik}|\, cos(\delta_i - \delta_k - \theta_{ik}) \quad (11)$$

and

$$Q_i = \sum_{k=1}^{n}|V_iV_kY_{ik}|\, sin(\delta_i - \delta_k - \theta_{ik}) \quad (12)$$
$$i = 1,2,\dots,n; \qquad i \neq slack\ bus$$

Equations (11) and (12) are nonlinear and it is required to solve $2(n-1)$ of such equations involving |Vi |, δi, Pi, and Qi at each bus i for the load flow solution (Nagrath, and Kothari, 1997). Different methods are available for load flow analysis of a typical power system. It is almost impossible to say which of the existing methods is the best, because the behaviour of different load flow methods is dictated by the types and sizes of the problems to be solved as well as the precise details to implementation (Nagrath, and Kothari, 1997). Choice of a particular method in any given situation is normally a compromise between the various requirements of an ideal load flow methods (Nagrath, and Kothari, 1997); high speed, low storage, reliability for ill-conditioned systems, versatility in handling various adjustments and simplicity in programming. Fortunately, not all these desirable features of a load flow method are needed in all situations. In this study, the Newton Raphson (NR) method is used because for a large network, the NR method is faster, more accurate and more reliable due to its quadratic convergence characteristics. The rate of convergence of NR is independent on the number of buses in the network; and convergence is not affected by the choice of the slack bus, number of buses and the presence of series capacitor (Nagrath, and Kothari, 1997).

2.2.2 Short Circuit Calculation

For short circuit studies, IEC 60909 (2016) short circuit calculation standard is used. It has the advantage that the pre-fault voltages need not be known to get accurate results. It is used when peak currents, the breaking currents and the steady state currents are to be calculated.

The following steps are followed for the calculation of the initial symmetrical short-circuit current I_k'', the symmetrical short circuit breaking current Ib, and the steady-state short-circuit current Ik at the short-circuit location (IEC 60909, 2016).

1) Calculate the equivalent voltage at the fault location $cV_n/\sqrt{3}Z_k$;
2) Determine and add up the equivalent positive-sequence, negative-sequence and zero-sequence impedances upstream of the fault location;
3) Calculate the initial short-circuit current using the symmetrical components.

Once the rms $I_k^{"}$ is known, others can be calculated using (IEC 60909, 2016);

$$I_k^{"} = \frac{cV_n}{\sqrt{3}Z_k} \quad (13)$$

$$Z_k = |R_k + jX_k| \quad (14)$$

where, c is the voltage factor that accounts for the maximum system voltage, V_n is the nominal system voltage at the fault location (V), Z_k is the equivalent positive sequence short circuit impedance (Ω). R_k and X_k are the sum of the series-connected resistances and reactances of the positive-sequence system respectively.

Using the real R and reactive X components of the equivalent positive sequence impedance Z_k, we can calculate the X/R ratio at the fault location, i.e.

$$X/R = \frac{X_k}{R_k} \quad (15)$$

The peak short circuit current Ip is then calculated as follows (IEC 60909, 2016);

$$I_p = 1.15\beta \times \sqrt{2}I_k^{"} \quad (16)$$

where β is a constant factor, $\beta = 1.02 \times 0.98e^{\frac{3}{X/R}}$

The Ib is the short circuit current at the point of circuit breaker opening. This is the current that the circuit breaker must be rated to interrupt fault and is typically used for breaker sizing. The symmetrical breaking current for meshed networks can be conservatively estimated as follows (IEC 60909, 2016)

$$I_b = I_k^{"} \quad (17)$$

For close to generator faults, the symmetrical breaking current will be higher

2.2.3 Transient Stability Analysis

The equal-area criterion cannot be directly used to determine the stability of multi-machine systems. Although the physical phenomena observed in one-machine-infinite-bus system are basically the same as in the multi-machine case, the complexity of the numerical computation increases as the number of machines increases (Ghosh, 2009).

The first step in the transient stability analysis is to solve the initial load flow and determine the initial bus voltages. The machine currents prior to disturbance are calculated from

$$I_i = \frac{S_i^*}{V_i^*};\ i = 1, 2, \dots, m \quad (18)$$

where, m = number of generators, V_i = Terminal voltage of the i^{th} generator, $S_i = P_i + jQ_i$ = complex power of the generator i.

The generator voltage behind the transient reactance (neglecting the resistance) is obtained as

$$E_i' = V_i + jX_d' I_i \quad (19)$$

The load admittance is then equivalent to;

$$y_{i0} = \frac{S_i^*}{|V_i|^2} \quad (20)$$

To form the resultant Y_{bus} matrix, the $n - bus$ network is added to the m generator internal buses with voltages E_i'. Using the Kron reduction method, all buses (other than the generator internal buses) are eliminated. The reduced bus admittance matrix of dimension $(m\ x\ m)$ be denoted as Y_{bus}^{red}. Then the electrical power output (Anderson, 1973);

$$P_{ei} = \sum_{j=1}^{m} |E_i'|\,|E_j'|\,|Y_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j) \quad (21)$$

where, $E_i' = |E_i'|\angle\delta_i$ and $Y_{ij} = |Y_{ij}|\angle\theta_{ij}$ and Y_{ij} is the ij^{th} element of Y_{bus}.

A three-phase fault at bus k results in the bus voltage $V_k = 0$. The k^{th} row and column are removed from the pre-fault bus admittance matrix to simulate the new scenario. Let the new bus admittance matrix is reduced by eliminating all buses except the internal generator buses. The generator excitation voltages during the fault and post fault condition are assumed to remain constant. (15) (15)

(16)

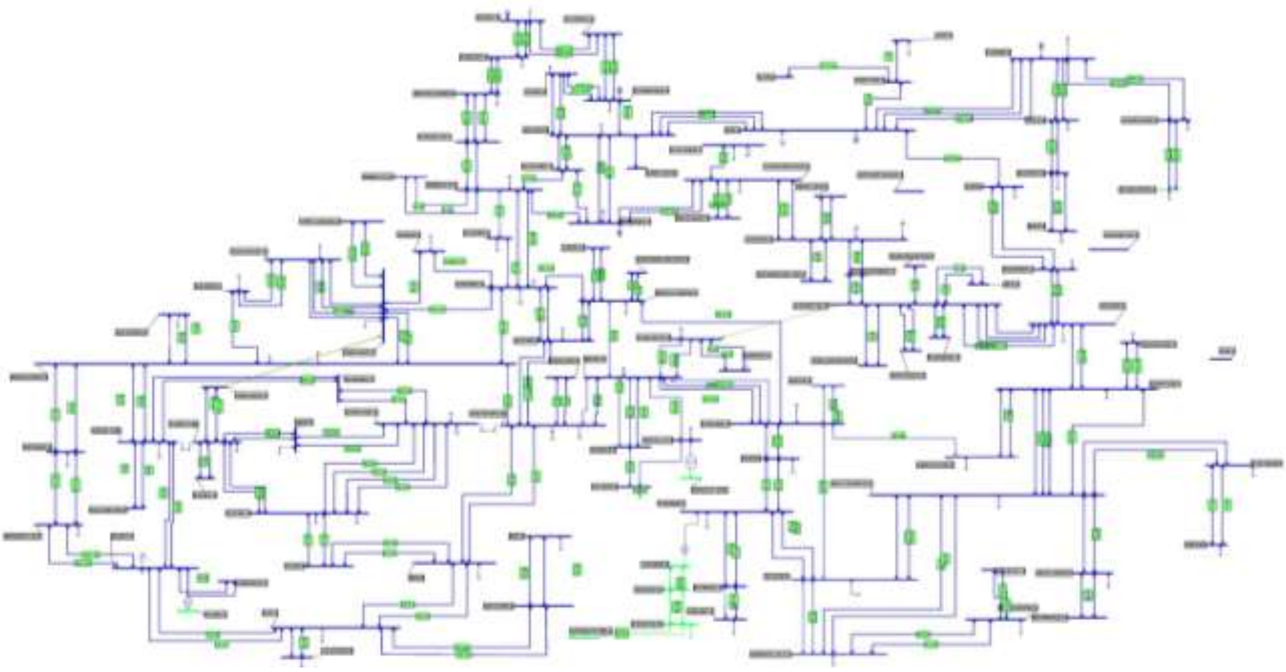

Fig.2: The NEPLAN model of the planned TCN 330 kV Network

The electrical power of the i^{th} generator in terms of the reduced bus admittance matrix is obtained from (21); therefore, the swing equation for machine i becomes (Anderson, 1973)

$$\frac{H_i}{\pi f_0}\frac{d^2\delta}{dt^2} = P_{mi} - P_{ei} = P_{ei} - \sum_{j=1}^{m}|E_i'|\,|E_j'||Y_{ij}|\cos\left(\theta_{ij} - \delta_i + \delta_j\right) \quad (22)$$

where, $H_i =$ inertia constant of machine i expressed on the common MVA base.

The post-fault bus admittance matrix is recalculated when the fault is cleared to reflect the change in network and then the simulation is continued using the post-fault bus admittance matrix. The system is said to be stable if the angle differences of the generators with respect to the reference generator swing back after reaching the maximum, otherwise the system is unstable.

3 Results and Discussion

The NEPLAN model of the planned and existing TCN network is shown in Fig. 2. The results of the base and the study cases are presented in this subsection. The base case is made up of a peak on-grid generation capacity and peak load demand of 14.9 GW and 14.3 GW respectively. In the study case, a 400 MW Sagamu IPP was added to the base case peak generation and load through ongoing Ogijo 330/132 kV substation.

3.1 The results of Load flow studies

The power flow analysis was carried out to determine voltage profile of the entire 330 kV grid, transmission line loading, transformer loadings profile and the possible losses encountered in the network. In both the base and the study cases, Fig. 3, the voltage profile is within acceptable limits (0.85 pu-1.05 pu) at all the 330 kV bus bars. In the base case, the minimum voltage of 322.672kV was experienced by Apo 330 kV bus and the maximum of 342.019 kV at Sapele 330 kV bus bars. Bus angles range from about +11.5º at Ikot Abasi to -38.1º in Bali, reflecting long electrical distances. In all, bus-to-bus angle spread is good.

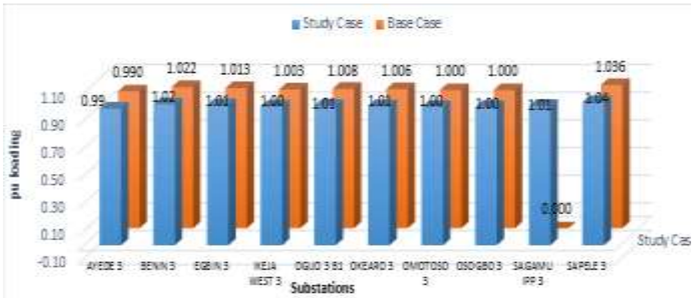

Fig. 3: Bus Voltage Profile

For the study case, a voltage of 332.558<15.90 kV was recorded at Ogijo bus. At Egbin, Omotoso and Ikeja West 330 kV buses, the bus voltages marginally changed to 334.128 kV, 330 kV, and 330.831 kV respectively. The bus voltage angle ranges from -27.9° at Yola 330 kV Substation to 19.3° at Sapele 330 kV bus.

3.1.1 The results of Equipment Loading

For the study case, there are no overloaded elements; however, many transmission lines are loaded up to 50%. Fig. 4 shows the 330 kV transmission circuits that are loaded above 50% of its capacity. Total loss in the network; which includes generator, transmission line and transformer losses, is 407.33MW; this is about 3% of the total generation dispatch.

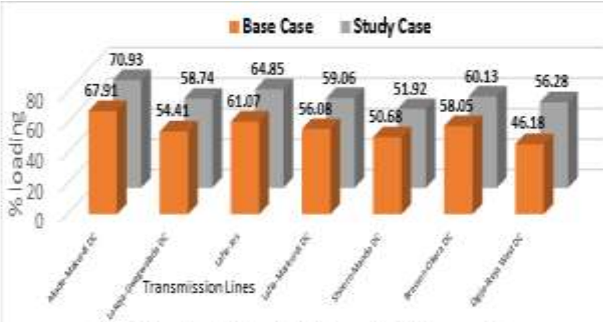

Fig. 4: Transmission lines loaded above 50% of its capacity in the Network

3.2 The results of Short Circuit Studies

The short circuit analysis was carried out to determine fault current levels at the various buses within the interconnected system for the purpose of checking switchgear rating adequacy. This was achieved by applying a 3-phase dead fault on each of the 330 kV bus bars in the network under study. The highest fault current level of 59.782 kA (breaking current) was recorded at planned Ogijo 330 kV substation after a 3-phase short circuit was applied at all buses. This fault level at this substation is as a result of the grid interconnectivity in that substation. Fig. 5 shows the fault breaking current of all substations buses with fault current level above 20 kA.

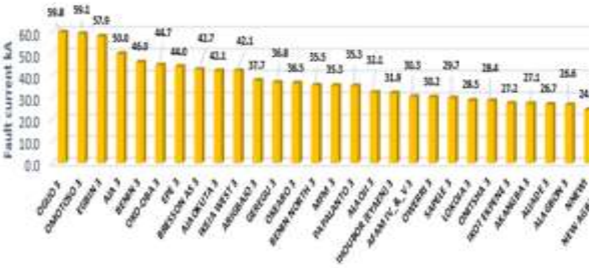

Fig. 5: The results of 3-Phase short circuit studies

The ratings of existing switchgears at Omotoso, Benin, Ikeja West, and Egbin substations are 50 kA, 40 kA, 40 kA, and 31.5 kA respectively. It is evident from Fig. 5 that the fault current levels obtained during simulation exercises for each of aforementioned substations are far more than their existing switchgears ratings. Therefore, it can be stated that the short circuit studies indicate that fault levels at Omotoso, Benin, Ikeja West, and Egbin 330 kV substations may exceed the rating of existing switchgears when the planned power plant and transmission development projects in the area are completed.

3.2.1 The results of Reduction of Fault Current Level through Substation Splitting

In order to reduce the short circuit current in the network, substation splitting was carried out in Ogijo and Omotoso 330 kV substations by opening the bus coupler (Fig. 2). These substations were chosen due to high fault current level existing at the two substations in the base case model. Fig. 6 shows the new fault current level existing in the network after splitting Ogijo and Omotoso substations. The percentage fault current reductions as a result of the splitting are shown in Fig. 7.

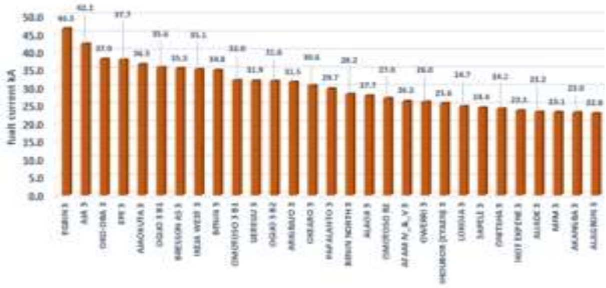

Fig. 6: The results of 3-Phase short circuit studies after substation splitting

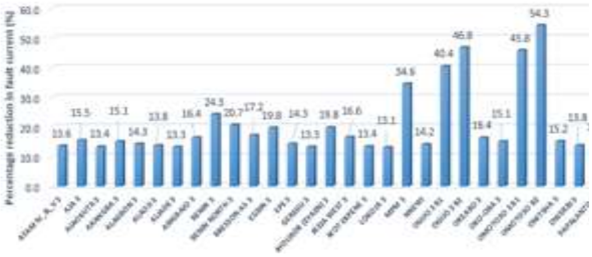

Fig. 7: Percentage reduction in fault current in substation buses after splitting

It is evident from Fig. 6 that splitting of Ogijo and Omotoso 330 kV substations will ensure that the rating of the existing circuit breakers in Benin, Omotoso and Egbin are not exceeded when the grid expansion plan in TCN network is fully actualized. It can be seen in Fig. 7 that the minimum gain in fault current across all bus was 13% of the initial value before splitting; and this will give room for further increase in the generation capacity of the network. Due to the connectivity of the system, the fault level at different buses are affected differently, this is due to the impedance of the circuit lengths.

3.3 The results of Transient Stability Studies

A 3-phase to ground fault was applied at Ogijo 330 kV bus for 150 ms. This is simulated by introducing a shunt of 0.00001 p.u reactance at the substation. The shunt is initially switched out, and is switched in at 2.0 seconds or 2000 ms after the study starts and it is then cleared after 7.5 cycles to determine the response of the various generating units for the fault clearing time.

3.3.1 The results of Bus and Rotor Angle

The angle curves (Fig. 8) for various power plants in the system show that the synchronism of the entire system is kept. The differences in angle between the various units are low. It is also observed that there is uniform oscillation of bus voltage angles to a new position which is within the acceptable limit, also verifying the stability of the system. Angular variations of other units in the system are not too different from each other. In general, the speed of all other units is relatively coherent with diminished oscillation.

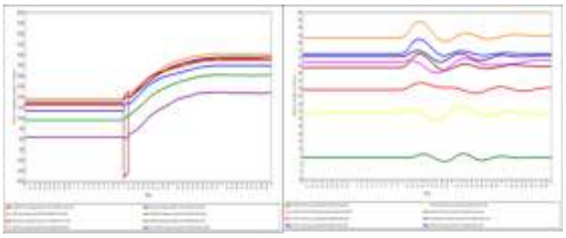

Fig 8: Bus and rotor angle with 3-phase to ground transient fault at Ogijo 330 kV bus

3.3.2 The Results of Bus and Rotor Frequency

In case of the rotor frequency (Fig. 9), the maximum spike of 50.151Hz in 0.176 seconds was recorded at the new power plant Generator unit after the fault is applied while the spikes of other units are relatively lower. Also, the maximum spike in bus frequency of 50.079 Hz is experienced by Egbin Bus in 0.01 seconds after the application of fault. For the bus frequency, the maximum spike of 49.96 Hz occurred at Kanji 330 kV bus, this is within the standard limit. These observations confirm that the system is stable.

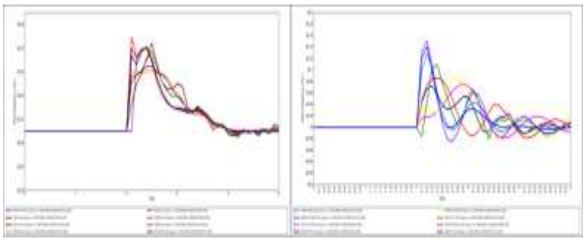

Fig 9: Bus and rotor frequency with 3-phase to ground transient fault at Ogijo 330 kV bus

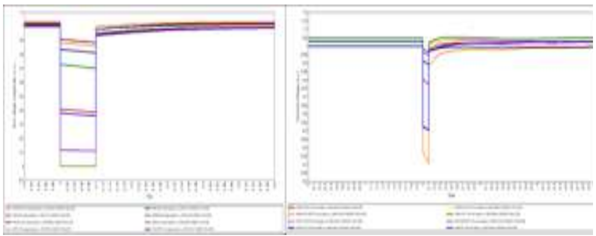

Fig 10: Bus and Rotor terminal voltage magnitude with 3-phase to ground transient fault

Fig. 10 shows the bus and rotor terminal voltage magnitude plots. The voltage dropped during the fault application and restored to its equilibrium state immediately the fault was cleared. Thus shows that the system can sustain a fault that last for 7.5 cycles without loss of synchronism.

3.3.3 Effect of Substation Splitting on Transient Stability

After splitting Ogijo and Omotoso substations, a transient 3-phase short circuit to ground fault was simulated on Ogijo 330 kV bus to study the effect of the splitting on the bus frequency and angle. The transient stability plot of bus frequency at Ikeja West, Egbin, Ogijo and Omotoso are shown in Fig. 11, while that of bus angles are shown in Fig. 12.

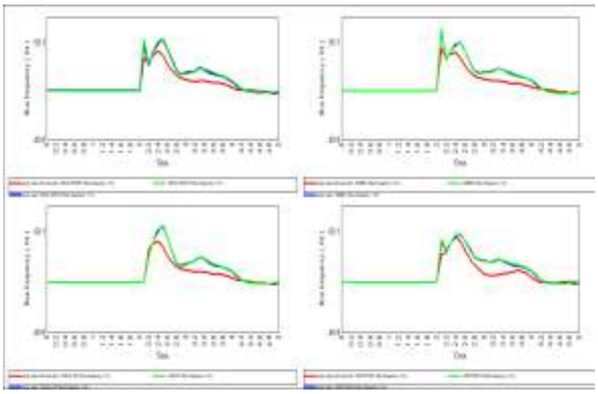

Fig 11: Bus frequency plots after substation splitting

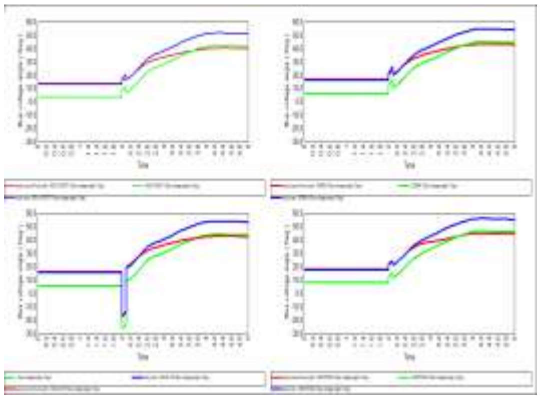

Fig 12: Bus angle plots after substation splitting

In Figs. 11 and 12, the plots in green represents the base case plots, the plots in blue are for the study case without substation splitting while the plots in red are study case plots with substation splitting. It is evident from the figures that after substation splitting (plot in red) the frequency spike as a result of transient fault was lower in all the plots and the bus angles simulated after splitting (plots in red) reached a new steady state before other plots without substation splitting. This shows that the stability of the system is improved when splitting is applied.

3.4 The Results of Contingency Analysis

In this study, only N-1 criterion was considered. The power flow studies were repeated with one circuit of Ogijo-Ikeja West line removed. A major consequence of this removal was that the retained circuit of Ogijo-Ikeja West line increased from 56.3% to 80.8% loading. Also another contingency considered was the breakdown of one of the Bresson-Okearo DC lines; we observed that the retained circuit increased from 60.13% to 102.4%. In all the contingency events considered, the loading on other adjoining lines marginally changed too. This over load in Bresson-Okearo line was not actually caused by IPP plant; rather, it is an existing issue in the base case network. These are shown in Table 5.

4 Conclusion

In this study, all the necessary studies needed for the effective evacuation and integration of a new power plant to an existing power network have been carried out; and each of them gives technical information, which can be used to ensure smooth operation of an emerging power grid. The power flow studies have shown that voltage profile and equipment loading as a result of integrating the new power plant to the grid is good. The short circuit studies show that the fault currents at Omotoso, Benin, Ikeja West and Egbin substations are most likely to go beyond the rating of existing circuit breakers available in the substations when ongoing transmission expansion projects are completed; therefore, there is need for substation splitting at Ogijo and Omotoso 330 kV substations in order to reduce the short circuit current level in the grid when the planned grid expansion project is completed. The transient stability studies reveal that the system stability is maintained after being subjected to a transient fault for 7.5 cycles. The results of contingency analysis indicate that the transmission capacity in Egbin-Okearo-Ikeja West cannot withstand N-1 criterion when the ongoing grid expansion programme is implemented; therefore, there is need for the increase in transmission capacity of Egbin-Okearo-Ikeja West axis to prevent overloading of the transmission lines in the event of single line outage.

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Table 5: Contingency Analysis results

			Normal Network			Ogijo-Ikeja Line 1 out			Bresson-Okearo Line 1 out		
S/N	From	To	P	Q	Loading	P	Q	Loading	P	Q	Loading
			MW	Mvar	%	MW	Mvar	%	MW	Mvar	%
1	OKEARO 3	BRESSON AS 3	**-457.303**	**-48.527**	**60.13**	**-523.6**	**-45.5**	**68.6**	**-779.5**	**-68.2**	**102.4**
2	OKEARO 3	BRESSON AS 3	**-457.303**	**-48.527**	**60.13**	**-523.6**	**-45.5**	**68.6**	**0**	**0**	**0**
3	OGIJO 3 B2	OGURU 3	-326.842	17.32	42.79	-358	20.3	46.9	-345.9	-19	45.3
4	OGIJO 3 B2	OGURU 3	-326.842	17.32	42.79	-358	20.3	46.9	-345.9	-19	45.3
5	OGIJO 3 B2	WTES I 3	-192.081	-42.658	25.72	192.1	-42.5	25.7	192.1	-42.5	25.7
6	OGIJO 3 B2	WTES I 3	-192.081	-42.658	25.72	192.1	-42.5	25.7	192.1	-42.5	25.7
7	OGIJO 3 B2	MFM 3	-58.331	44.788	9.61	-75.7	48	11.7	-69.4	-47.4	11
8	OGIJO 3 B2	MFM 3	-58.331	44.788	9.61	-75.7	48	11.7	-69.4	-47.4	11
9	OGIJO 3 B1	SAGAMU IPP 3	-199.509	29.788	26.33	-199.5	-35	26.4	-199.5	-33	26.4
10	OGIJO 3 B1	SAGAMU IPP 3	-199.509	29.788	26.33	-199.5	-35	26.4	-199.5	-33	26.4
11	OGIJO 3 B1	EGBIN 3	-160.317	-52.532	22.02	-46.6	-65.1	10.4	-187.3	-62	25.7
12	OGIJO 3 B1	EGBIN 3	-160.317	-52.532	22.02	-46.6	-65.1	10.4	-187.3	-62	25.7
13	OGIJO 3 B1	TIGBORO 3	-122.504	-5.681	16.01	-115.4	-0.6	15	-138.2	-1.6	18
14	OGIJO 3 B1	TIGBORO 3	-122.504	-5.681	16.01	-115.4	-0.6	15	-138.2	-1.6	18
15	**IKEJA WEST 3**	**OGIJO 3 B1**	**-428.878**	**6.569**	**56.28**	**-615.9**	**27.7**	**80.8**	**-471.1**	**-11.4**	**61.8**
16	**IKEJA WEST 3**	**OGIJO 3 B1**	**-428.878**	**6.569**	**56.28**	**0**	**0**	**0**	**-471.1**	**-11.4**	**61.8**
17	IKEJA WEST 3	OKEARO 3	-266.11	-9.828	34.94	-330.9	-1.8	43.4	-205.7	-0.9	27
18	IKEJA WEST 3	OKEARO 3	-266.11	-9.828	34.94	-330.9	-1.8	43.4	-205.7	-0.9	27
19	BRESSON AS 3	EGBIN 3	-269.742	-2.963	35.1	-336.4	-8.6	43.7	-202.7	-6.8	26.3
20	BRESSON AS 3	EGBIN 3	-269.742	-2.963	35.1	-336.4	-8.6	43.7	-202.7	-6.8	26.3
21	ARIGBAJO 3	OGIJO 3 B2	-349.973	63.131	46.38	-394.4	72	52.3	-377.1	-68.9	50
22	ARIGBAJO 3	OGIJO 3 B2	-349.973	63.131	46.38	-394.4	72	52.3	-377.1	-68.9	50